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(58) Reference documents:
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(54) HEAT TREATMENT METHOD FOR A FILM

CLAIM

1. A heat treatment method for a film characterized by the fact that in the method for heat treatment by supplying heated air to the film rolled by the provision of a gap in a roll shape and supported so that the rolling axis is vertical, the gap of the film is maintained with net shaped spacer tapes included on both ends of the film; the film itself is supported with a metal flat plate with a smooth surface provided with air holes having a diameter of 0.5 mm to 30 mm in the range of the degree of opening of 10 % to 80 %; and air at 120°C to 180°C as is delivered the heated air at an air velocity of 0.05 m/sec to 1 m/sec from the rear of said flat plate.

DETAILED EXPLANATION OF THE INVENTION

Application field

The present invention relates to a heat treatment method for a film to obtain film with an excellent hot dimensional stability by heat treatment of wide and long film. In particular, a wide and long film with excellent hot dimensional stability is useful in the heat treatment of plastic film by lamination of the photo selective transmission film, transparent electrically conductive film or other functional films for use in optical and electrical applications.

Conventional technology

As the heat treatment method for film, the treatment method varies with the length of the film. As the treatment methods of a relatively short film, there are methods for (1) continuous treatment at low speed in a tunnel type continuous furnace and/or on a roll or a flat plate heated to a high temperature in contact or not in contacting, and (2) relatively loose rolling of the film and heat treatment as such in a heating furnace (please refer to, for example, Japanese Kokai Patent Application No. Sho 58 [1983]-98219). In the case of a relatively long one, (3) the methods for including the spacer between the rolled layers and carrying out the heat treatment of the roll shaped film in a heating furnace (for example, Japanese Kokai Patent Applications Nos. Sho 60 [1985]-82338 and Sho 62 [1987]-127229) are known. However, the conventional methods described above have the following problems.

The methods of (1) are effective methods if the heat treatment time is from a few minutes to tens of minutes or so. However, in general, the time is often insufficient. If the heat treatment time is long, the heating furnace will also be long and the facility cost will increase markedly in an uneconomical manner. Furthermore, there will be blocking, scratching and other problems. In the case of (2), it is difficult to roll a wide, long film loosely. Furthermore, the deformation and the scratching of the film due to a rolling discrepancy will easily occur. In the method (3), the problems in the method (2) are overcome. However, the heat conduction between the various films is slow and it takes time to heat the roll shape film as a whole, owing to the presence of the air layer between the films as in the case of Japanese Kokai Patent Application No. Sho 60 [1985]-82338. Thus, the difference in the heat treatment temperature and the time in the length direction of the film is large. There is a large difference in the thermal dimensional stability of the film. Furthermore, even if a spacer having gas passage characteristics is used, the time is shortened more or less only compared to not using it, and no solution is achieved. Thus, in the case in which the heat treatment time difference occurs in this manner, for example, in the

case of transparent electrically conductive film, there is a large variation in the product quality in the length direction and the width direction of the film.

Furthermore, in the case in which the roll shaped film rolled with the inclusion of the spacer is maintained horizontally inside the heating furnace, for the film width more than 500 mm, since the film is maintained at a high temperature, owing to softening the central portion of the film is easily deformed by its own weight. There is a disadvantage in which the deformation remains as such after the heat treatment. Depending on the situation, blocking or scratching may occur from contact with films accompanying the film deformation during the heat treatment. Moreover, in the case in which the roll shaped film with the inclusion of the spacer is maintained vertically inside the heating furnace, if the film width is more than 500 mm, there is a problem in which marked deformation occurs on the lower end.

For example, according to Japanese Kokai Patent Application No. Sho 62 [1987]-127229, since the film is rolled inside the heating furnace, there is no temperature difference or time difference due to heating. However, as mentioned previously, it is difficult to avoid film deformation.

Objective of the invention

In view of such current situations, the present invention has the objective to provide a heat treatment method capable of yielding a good quality film with uniform heat treatment even in the length direction for a wide, long film without the occurrence of deformation of the film, blocking scratching or the like.

Constitution and actions of the invention

The objective described above can be achieved by the present invention as in the following.

The present invention is a heat treatment method for a film characterized by the fact that in the method for heat treatment by supplying heated air to the film rolled by the provision of a gap in a roll shape and supported so that the rolling axis is vertical, the gap of the film is maintained with net shaped spacer tapes included on both ends of the film; the film itself is supported with a metal flat plate with a smooth surface provided with air holes having a diameter of 0.5 mm to 30 mm in the range of the degree of opening of 10 % to 80 %; and air at 120°C to 180°C is delivered as the heated air at an air velocity of 0.05 m/sec to 1 m/sec from the rear of said flat plate.

There are no special restrictions on the film that can be applied appropriately in the present invention as long as it can stand the heat treatment to be described later. It is a plastic

film to be described next, a film obtained by the lamination of a functional thin film on this as a substrate, or the like.

As plastic films, for example, films of polyethylene terephthalate, polyethylene naphthalate, polystyrene, polycarbonate, triacetate, polysulfone, polyether sulfone, polyimide, polyamide imide and so on can be mentioned. From heat resistance, humidity resistance, thermal dimensional stability and so on, preferably polyethylene terephthalate film can be used. The functional thin film using the film mentioned above as the substrate is, for example, a transparent electrically conductive film, a photo selective transmission film or the like processed by vapor deposition, sputtering, chemical coating and so on. The heat treatment for the improvement of the electrical characteristics, optical characteristics, mechanical characteristics, heat resistance, humidity resistance and so on of the film in the formation of said thin film, is the heat treatment necessary to maintain the time above a certain level, and the specified treatment temperature can be used in general.

With reference to the following diagrams, the present invention will be explained in detail.

Figure 1 is the constitutional diagram of the device used in the application examples of the present invention. Figure 2 shows the example of the net shaped spacer tape. Figure 3 shows the roll support stand.

In the present invention, first of all, at a temperature less than the glass transition temperature of the film and with the inclusion of the net shaped spacer tape (2) along both ends of the film (1), the film (1) is wound on the bobbin (4). Next, said wound roll is placed on the support stand (6) of the heating furnace (5). The heated air (8) is introduced and the heat treatment is carried out at the specified temperature for the specified time. There are no special restrictions on the net shaped spacer tape (2) that can be used in the present invention as long as it is a net shaped material that can maintain the gap of the film at a constant level. As the number of yarn materials per inch constituting the net, one with 10 meshes to 100 meshes can preferably be used. In particular, one with 15 meshes to 60 meshes can render good results.

As the weaving methods for the net shaped spacers, flat weaving, twill weaving or other ordinary methods are acceptable. Furthermore, as the materials for use, polyester filaments, nylon filaments, polypropylene filaments, polyethylene filaments and so on can be used. In particular, polyester filaments can preferably be used because of their high heat resistance.

The net shaped spacers are preferably monofilaments [configured] in the manner described above. This is because of the fact that, if they are ordinary short fibers, the cutoff wastes generated during their usage become waste and are adhered to the film being subjected to the heat treatment. Of course, if they do not become waste or produce other problems, it goes without saying that they are not limited to this.

Furthermore, if the meshes of the net shaped spacers are more than the range mentioned above, the air passage amount will not be sufficient. It takes time to heat to the inside of the roll (5) [sic] during the heat treatment. Moreover, if they are less than the range mentioned above, the flatness of the net shaped spacer itself will be poor and deformation of the film will occur easily.

In the case of the thermal shrinkage of the heat treated film, material of the same kind as the film (1) to be heat treated is preferred, if possible. In other words, if the net shaped spacer tape (2) is of the same kind as the film (1) to be heat treated, the thermal shrinkage ratio will be about the same. Even in the case of the thermal shrinkage due to heat treatment after winding, the deformation due to the winding discrepancy, the winding closure and so on can be brought to a minimum. In order to prevent the formation of oligomers and so on, the net shaped spacer tape (2) is preferably a material that has been pretreated beforehand.

Furthermore, by increasing the width and the thickness of the net shaped spacer tape (2), the gap (3) between films will increase in an advantageous manner. However, the cutoff width of the film end side of the trace of the net shaped spacer tape (2) at the end of the heat treatment is increased and the loss is increased. Furthermore, the diameter of the roll will increase in a disadvantageous manner. Moreover, the weight of the net shaped spacer tape (2) itself will increase and deformation of the lower end side of the roll will occur. Thus, it is necessary to select the width of the net shaped spacer tape (2) according to the film width. In general, this is 5-50 mm wide and the thickness is preferably 0.1-1.5 mm.

For the roll support stand (6) to be used in the present invention, the air holes (7) shown in the example of Figure 3 have a diameter of 0.5-30 mm, and the degree of opening defined as the ratio of the total air hole area with respect to the total surface area of the support stand is 10% to 80%. The support stand (6) has to be a flat plate in order to maintain the roll. Furthermore, it is important that the coefficient of friction with the film end side is small.

For this, a material is required having sufficient strength so that deformation due to own weight of the wound film does not occur. Thus, it is preferable that the support stand (6) is of a metal. Furthermore, for the wound film, expansion or shrinkage occurs owing to the thermal shrinkage of the film under the heat treatment conditions or the temperature rise up to the heat treatment temperature or the linear expansion coefficient during processing. When the film lower end side moves on the support stand (6) and if the friction is large, deformation of the film will occur. Thus, material is used with mechanical processing so that the frictional resistance of the surface of the support stand (6) is decreased, or with coating of a fluorine resin or other resins.

In the present invention, for the heated air (8) for passage from the rear of the support stand (6) supporting the roll mentioned above, the air temperature and the air delivery rate have a

major effect on the film deformation. In particular, the air delivery rate is important. It is essential that heating is carried out so that the temperature level is virtually uniformly increased from the lower end toward the vertical direction.

The air temperature is 120°C to 180°C, preferably 130°C to 170°C. The air delivery rate as the air amount flowing between films is 0.05 m/sec to 1 m/sec, preferably 0.1 m/sec to 0.8 m/sec. If less than the conditions mentioned above, the heat treatment will require more time. If more than the conditions mentioned above, it will cause deformation of the film.

The present invention, as described in detail above, is a method that can be used effectively for a long film with a film width of more than 500 mm. It proposes a new method without using the spacer tape alone as in the conventional proposal.

Application Example

A polyester film with a thickness of 125 μm, a film width of 1000 mm and a length of 200 m was first subjected to a preliminary treatment so that no oligomers appeared at the heat treatment temperature.

Next, said film was wound at room temperature (25°C) by using a net shaped spacer with a polyester film filament diameter of 200 μm, 400 meshes and a width of 25 mm. The net shaped spacer was positioned on both ends of the film.

By using an aluminum plate (plate thickness 6 mm) with an air hole diameter of 8 mm and a degree of opening of 58.2 % as the support stand (6), the film mentioned above was placed on top of the said support stand.

Next, the temperature of the heating surface was set at 150°C. The air delivery static pressure of the heating furnace was increased so that the air delivery speed between the films was 0.4 m/sec. During the heat treatment, the difference between the bottom portion with the fastest temperature rise of the film and the top portion with the slowest rise was 4 hr.

BRIEF EXPLANATION OF THE FIGURES

Figure 1 is the constitutional diagram of the heat treatment device used in the application example of the present invention. Figure 2 shows illustrative diagrams of the plan and the cross-section of the net shaped spacer in Figure 1. Figure 3 is the planar diagram of the support stand.

1 Film
2 Spacer
3 Space

4 Winding bobbin
5 Heating furnace
6 Support stand
7 Air hole
8 Hot air

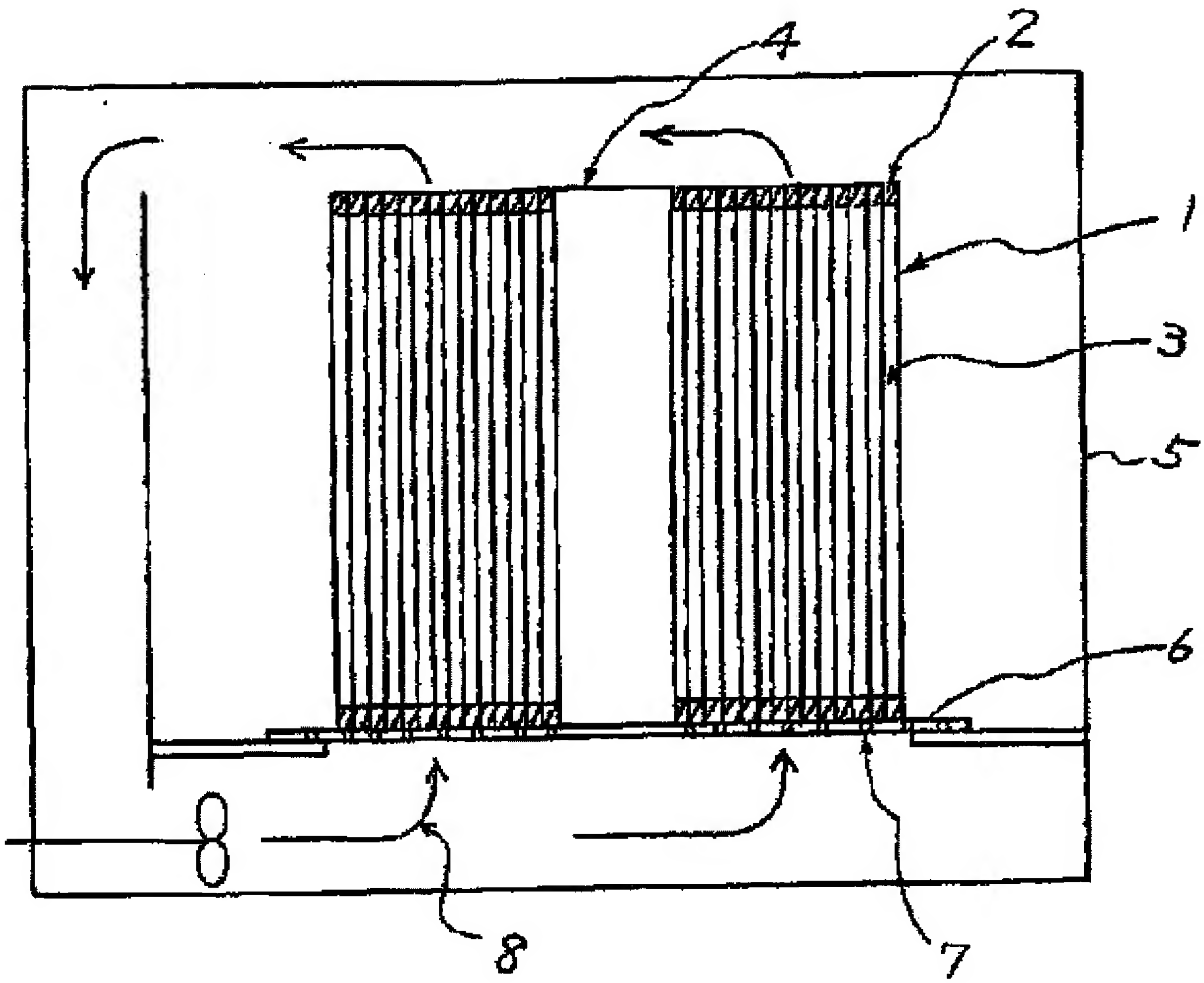

Figure 1

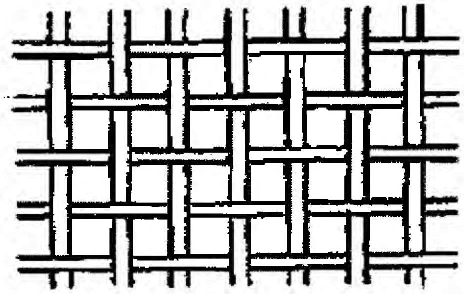

Figure 2 (a)

Figure 2 (b)

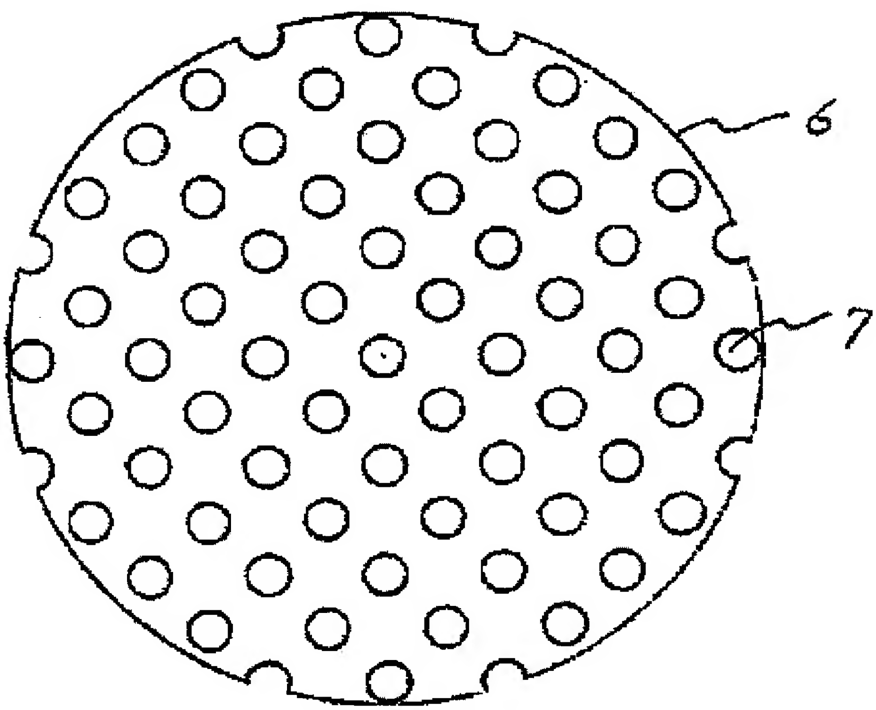

Figure 3